CLAIMS

What is claimed is:

1. A method of controlling the oxidation of a hydrocarbon to an intermediate oxidation product in a reaction zone, the method characterized by the steps of:

(a) contacting a gas comprising oxidant with a hydrocarbon by feeding the gas at a first flow rate, and the hydrocarbon into the reaction zone, at a first pressure, and at a first temperature adequately high to allow the oxidant to react with the hydrocarbon at a reaction rate and/or reactivity; and

(b) controlling the consumption rate of the oxidant in a manner that the reaction rate and/or the reactivity are maintained within or driven toward ranges of predetermined limits.

2. A method as defined in claim 1 wherein the consumption rate of the oxidant is determined by the difference of oxidant entering the reaction zone and oxidant leaving the reaction zone per unit of time.

3. A method as defined in claim 1 wherein the consumption rate of the oxidant is determined by the difference of hydrocarbon entering the reaction zone and hydrocarbon leaving the reaction zone per unit of time.

4. A method as defined in claim 1 wherein the consumption rate of the oxidant is determined by conducting at least one step of the following, after stopping gas feeding into the reaction zone and after stopping removal of non-condensible off-gases from the reaction zone:

(i) determining the time it takes for the oxidant contained in the reaction zone to cause a reaction in a manner that the reaction zone attains a predetermined second pressure, lower than the first pressure; and

(ii) allowing the oxidant to cause a reaction, and measuring the pressure drop within a predetermined interval of time.

5. A method as defined in claim 4 wherein the step of allowing the oxidant to cause reaction comprises a step of continuing contacting the oxidant with the hydrocarbon.

6. A method as defined in claim 1 wherein the consumption rate of the gaseous oxidant is determined by a difference between the first flow rate and the flow rate of non-condensible off-gases.

7. A method as defined in claim 1, 2, 3, 4, 5, or 6 wherein the consumption rate of the oxidant is controlled by regulating a variable selected from a group consisting of temperature, pressure, partial pressure of oxidant, flow rate of oxidant, sparging rate, recycled gas flow rate, flow rate of hydrocarbon, flow rate of solvent, flow rate of catalyst, flow rate of water, flow rate of initiator or promoter, and a combination thereof.

8. A method as defined in claim 1, 2, 3, 4, 5, 6, or 7, further comprising a step of atomization of liquids entering the reaction zone.

9. A method as defined in claim 1, 2, 3, 4, 5, 6, 7, or 8 wherein the intermediate compound comprises adipic acid, the hydrocarbon comprises cyclohexane, the solvent comprises acetic acid, the catalyst comprises a cobalt compound, and the optional initiator or promoter comprises a compound selected from a group comprising acetaldehyde, cyclohexanone, and a combination thereof.

10. A device for controlling the oxidation of a hydrocarbon to an intermediate oxidation product at a reaction rate or at a reactivity, or both, the device characterized by:

a reaction chamber;

oxidant feeding means, connected to the reaction chamber, for feeding predetermined amounts or rates of a gas comprising oxidant into the reaction chamber;

hydrocarbon feeding means, connected to the reaction chamber, for feeding a predetermined amount or rate of a hydrocarbon into the reaction chamber;

oxidant consumption determining means, connected to the reaction chamber, for determining the rate of oxidant consumption in the reaction chamber; and

oxidant consumption control means, connected to the reaction chamber, for controlling the rate of oxidant consumption in the reaction chamber in a manner to maintain the reaction rate or the reactivity or both within predetermined limits.

11. A device as defined in claim 10, further comprising a controller connected to the oxidant consumption determining means and to the oxidant consumption control means, the controller being programmed to obtain information from the oxidant consumption determining means and use this information to influence the oxidant consumption control means to be varied in a manner to cause the reaction rate or reactivity or both to be maintained within the predetermined limits.

12. A device as defined in claim 11, further comprising oxidant inlet monitoring means for determining the flow rate of oxidant entering the reaction chamber, and oxidant outlet monitoring means for determining the flow rate of oxidant exiting the reaction chamber, both monitoring means being connected to the controller for providing inlet and outlet flow information to the controller, the information being used for determining the rate of consumption of oxidant.

13. A device as defined in claim 11, further comprising

interrupting means for stopping temporarily in predetermined intervals entering of gases into the reaction chamber and exiting of non-condensible gases from the reaction chamber; and wherein

the oxidant consumption determining means comprise a pressure monitor for measuring the pressure inside the reaction chamber, and for providing pressure differential information to the controller, during the temporary stopping of entering and exiting gases, for determining the rate of oxidant consumption.

14. A device as defined in claim 11 wherein the oxidant consumption determining means further comprise gas entering means and non-condensible off-gas exiting means for determining the difference between flow of gas entering the reaction chamber and flow of gas exiting the reaction chamber, respectively, and determining the oxidant consumption rate from the difference of the flows.

15. A device as defined in claim 11, 12 13, or 14, further comprising one or more of:

temperature monitoring means for monitoring the temperature in the reaction chamber;

solvent feeding means connected to the reaction chamber for feeding a predetermined amount or rate of a solvent into said reaction chamber;

catalyst feeding means connected to the reaction chamber for feeding a predetermined amount or rate of a catalyst into said reaction chamber;

initiator or promoter feeding means connected to the reaction chamber for feeding a predetermined amount or rate of a promoter into said reaction chamber; and

recycle feeding means for recycling matter after at least partial removal of reaction products.

16. A device as defined in claim 15 wherein the controller is connected to the at least one of the temperature monitoring means, the oxidant feeding means, the hydrocarbon feeding means, the solvent feeding means, the catalyst feeding means, the recycle feeding means, and the initiator or promoter feeding means; the controller being programmed to adjust at least one of said temperature monitoring means, oxidant feeding means, hydrocarbon feeding means, solvent feeding means, catalyst feeding means, and initiator or promoter feeding means, in a manner to either give an indication to an operator, if the reaction rate or the reactivity or both is found to be outside the predetermined range, or to adjust the oxidant consumption rate so as to bring back and maintain said reaction rate or said reactivity or both within said desired range.

17. A device as defined in claim 15 or 16 wherein at least two of said oxidant feeding means, hydrocarbon feeding means, solvent feeding means, catalyst feeding means, and promoter feeding means are combined to one combination means.

18. A device as defined in claim 10, 11, 12, 13, 14, 15,16, or 17 wherein the reaction chamber is at least part of an atomization reactor.

19. A device as defined in claim 10, 11, 12, 13, 14, 15,16, or 17 wherein the reaction chamber is at least part of a stirred-tank reactor.